

# Preoperative Factors Associated With Postoperative Requirements of Renal Replacement Therapy Following Cardiac Surgery



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Renal dysfunction is a major adverse event after cardiovascular surgery. Therefore, the preoperative prediction of which patients will require renal replacement therapy (RRT) after cardiac surgery is an important issue. In the present study, 1,822 consecutive patients who underwent cardiovascular surgery from 2008 and 2013 at a single institution were reviewed. Patients who were already receiving long-term hemodialysis before surgery ( $n = 134$ ) were excluded. The remaining 1,688 patients were separated into 2 groups: those requiring postoperative RRT and those without RRT requirement. A total of 128 patients (7.6%) required RRT. Patients requiring RRT had greater perioperative blood loss, longer intubation time, and longer hospital stays ( $p < 0.0001$  for all). Multivariate analysis revealed that cardiopulmonary bypass use, preoperative body surface area, the left ventricular ejection fraction, serum albumin, and creatinine were independent risk factors for postoperative RRT (odds ratios 2.435, 0.204, 0.976, 0.556, and 5.394, 95% confidence intervals 1.471 to 4.140, 0.054 to 0.841, 0.962 to 1.025, 0.363 to 0.860, and 3.671 to 8.223, respectively,  $p < 0.05$  for all). A subgroup of patients with relatively preserved renal function before surgery (creatinine  $< 1.12$  mg/dl, a cut-off value for RRT requirement obtained from receiver-operating characteristic curve analysis [area under the curve 0.74748, sensitivity 60.2%, specificity 85.0%]) showed that preoperative serum albumin concentration was most significantly associated with postoperative RRT requirement (odds ratio 0.048, 95% confidence interval 0.023 to 0.095,  $p < 0.0001$ ). In conclusion, cardiopulmonary bypass use, preoperative renal impairment as reflected by elevated creatinine level, small body size, a low left ventricular ejection fraction, and hypoalbuminemia were associated with a requirement for postoperative RRT. In patients with preserved renal function, hypoalbuminemia was most significantly related to requirement for RRT. © 2015 Elsevier Inc. All rights reserved. (Am J Cardiol 2015;116:294–300)

Renal replacement therapy (RRT) after cardiac surgery is a strong predictor of poor postoperative outcome.<sup>1,2</sup> Previously reported preoperative risk factors for postoperative acute renal dysfunction requiring transient or permanent RRT included age,<sup>3,4</sup> female gender,<sup>3,5</sup> preoperative heart failure,<sup>2,3</sup> diabetes,<sup>5</sup> hypertension,<sup>6</sup> anemia,<sup>7</sup> cardiopulmonary bypass (CPB) use,<sup>8,9</sup> and preexisting renal dysfunction,<sup>2,4–6</sup> especially in patients who undergo emergency surgery under unstable conditions.<sup>3,4,7</sup> However, the factors associated with RRT in patients who undergo elective cardiac surgery in stable condition have not been fully evaluated. Therefore, we investigated the factors associated with postoperative RRT requirement in patients who underwent elective cardiac surgery under stable conditions. None of these patients were receiving any preoperative long-term RRT such as hemodialysis or peritoneal dialysis.

## Methods

The data collection protocol was approved by the Institutional Review Board of Juntendo University (Tokyo, Japan). A total of 1,822 consecutive patients who underwent elective cardiac surgery at the Juntendo University School of Medicine from December 2008 to October 2013 were eligible for retrospective entry into the study. Patients who underwent vascular surgery alone, such as ascending aorta replacement, were excluded from the study. A total of 134 patients (7.4% of the cohort) who were already receiving long-term dialysis before the surgery were also excluded. Data obtained from the remaining 1,688 patients were used for this retrospective study.

Patient data were obtained from hospital medical records. Laboratory values and echocardiograms obtained within 2 weeks before surgery were collected. If a patient had undergone multiple examinations, the last set of results immediately before surgery was used for the analysis. Postoperative outcome analysis included length of intensive care unit stay and total postoperative hospital stay, duration of ventilator support, amount of perioperative bleeding, and postoperative adverse events such as stroke and new-onset atrial fibrillation. Patients were divided into 2 groups: those who required transient or/and permanent RRT (hemodialysis or continuous hemodiafiltration) postoperatively and those who had no

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See page 299 for disclosure information.

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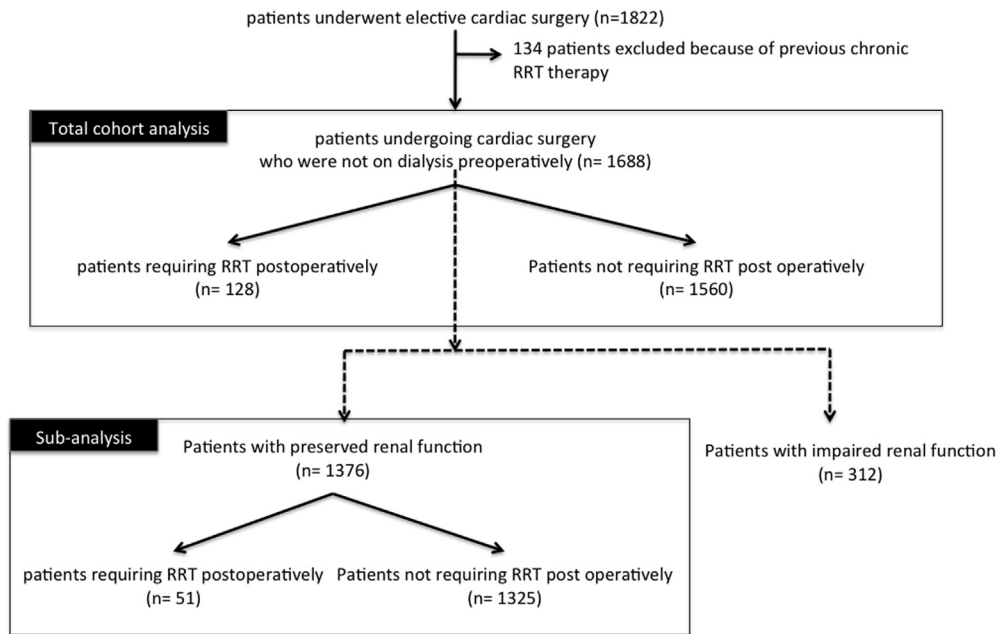


Figure 1. Flowchart of the selection of cardiac surgery patients for inclusion in the study and in the subanalysis.

Table 1  
Comparison of patients who required or did not require RRT after cardiac surgery

	Patients requiring RRT (n=128)	Patients not requiring RRT (n=1560)	p value
<b>Clinical characteristics</b>			
Age (years)	69.6±11.8	69.4±12.3	0.0057
Men	81(63.3%)	1077(69.0%)	0.1773
Body surface area (m <sup>2</sup> )	1.59±0.20	1.65±0.20	0.0024
Type of surgery			0.9392
Coronary artery bypass surgery alone	55(43.0%)	665(42.6%)	
Valvular surgery alone	59(46.1%)	700(44.9%)	
Coronary artery bypass surgery + Valvular surgery	14 (10.9%)	193(12.4%)	
Others	0(0%)	2(0.13%)	
Cardiopulmonary bypass usage	87 (68.0%)	881 (56.5%)	0.0120
Left ventricular ejection fraction (%)	52.4±17.4	59.6±13.9	< 0.0001
<b>Preoperative laboratory value</b>			
Hemoglobin (g/dL)	11.5±1.93	12.9±1.73	< 0.0001
Total bilirubin (mg/dL)	0.8±0.7	0.8±0.5	0.7560
Total protein (g/dL)	6.6±0.8	6.9±0.6	< 0.0001
Albumin (g/dL)	3.6±0.7	4.1±0.5	< 0.0001
Potassium (mEq/L)	4.4±0.5	4.3±0.4	0.0025
Sodium (mEq/L)	139.1±3.6	140.0±2.3	0.0003
Blood urea nitrogen (mg/dL)	30.7±18.2	17.8±7.4	< 0.0001
Creatinine (mg/dL)	1.8±1.20	0.9±0.3	<0.0001
Brain natriuretic peptide (pg/mL)	326.6 (134.1-888.0)	79.4 (33.0-192.4)	<0.0001
C-reactive protein (mg/dL)	2.00±3.77(n=105)	0.47±1.37 (n=1293)	<0.0001

postoperative RRT requirement. Preoperative information and postoperative courses were compared between the groups.

Preoperative factors associated with RRT requirement were investigated by uni- and multivariate logistic analysis. The cut-off value for the preoperative creatinine level associated with RRT requirement was calculated, and a subanalysis was also performed to investigate factors that would predict RRT requirement in patients with preoperative creatinine levels less than the cut-off value.

Data are presented as mean ± SD. Normality was evaluated for each variable using normal distribution plots and histograms. Variables were compared between the groups using Student's unpaired 2-tailed *t* test. The Mann-Whitney test was performed with median and interquartile values when the variables were not normally distributed. Categorical variables were compared using the chi-square test. Univariate logistic regression analysis was used to select potential variables associated with RRT requirement.

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